

Homework 1

Problem 1: One-step error probability

For the first part of the problem I wrote the following program in MATLAB:

```
p = [12, 24, 48, 70, 100, 120];
N = 120;
perror1 = [];
perror2 = [];

for m = 1:2
    perror = [];
    for i = 1:length(p)
        e=0;
        for j = 1:10^5
            pattern = 2*randi([0,1],N,p(i)) - 1;
            w = 0;
            for k = 1:size(pattern,2)
                w = w + mtimes(pattern(:,k),transpose(pattern(:,k)));
            end
            if m == 1
                w = w-diag(diag(w));
            end
            w = w/N;

            randPattern = pattern(:,randi(p(i)));
            randBit = randi(N);
            b = mtimes(w,randPattern);
            x_temp = sign(b(randBit));
            if x_temp ~= randPattern(randBit)
                e = e + 1;
            end
        end % trials loop

        perror = [perror e/10^5];
    end % patterns loop
    if m == 1
        perror1 = perror;
    else
        perror2 = perror;
    end
end
```

Problem 2: Recognising digits

For the second problem I wrote the following programm in MATLAB:

[illegible]


```
-1, -1, 1, 1, -1],[ -1, -1, -1, -1, -1, -1, -1, 1, 1, -1],[ -1, -1, -1, -1, -1,
-1, -1, 1, 1, -1],[ -1, -1, -1, -1, -1, -1, -1, 1, 1, -1] ];
```

Problem 3: Stochastic Hopfield network

For the third problem I wrote the following program in MATLAB:

```
p = [7,45];
beta = 2;
N = 200;
Mav = zeros(1, size(p,2));
for l = 1:size(p,2)
    Msum = 0;
    M=0;
    for j = 1:100
        patterns = [];
        for i = 1:p(l)
            patterns = 2*randi([0,1],N,i)-1;
        end
        w = 0;
        for k = 1:p(l)
            w = w + mtimes(patterns(:,k), transpose(patterns(:,k)));
        end
        w = w-diag(diag(w));
        w = w/N;
        x_temp = patterns(:,1);
        S = 0;
        for m = 1:10^3
            for n = 1:N
                b = mtimes(w,x_temp);
                r = rand;
                if r<1/(1+exp(1)^(-2*beta*b(n)))
                    x_temp(n) = 1;
                else
                    x_temp(n) = -1;
                end
            end % bits loop
            S = S + x_temp;
        end % time loop
        M = dot(S,patterns(:,1));
        Msum = Msum + M/(N*10^3);
    end % trials loop
    Mav(l) = Msum/100;
end
```